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ACOUSTIC CHARACTERISTICS OF POLYPROPYLENE
IN THE MIX WITH POLYTHENE

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Measurements of phase velocity and attenuation factor of ultrasound by frequency 2MHz in standard samples of a material polypropylene-polythene (PP-PT) are lead at change of a components parity of a mix from 0 up to 100 %. Results are received for cases of polythene of high density (PTHHD) and polythene of low density (PTLD). Various influence of these PT marks on dependences of acoustic testimonials versus % PT content in intermixture is revealed. For PTHHD these dependences are monotonous and are close to additive. In case of PTLD the velocity dependence is deviated from a monotonous course, and the attenuation factor has a minimum at 20 % PT content. Such behaviour of acoustic characteristics testifies to distinctions in character of interaction on interphase border with PP for these PT marks. The longitudinal elastic module and durability of an investigated mix on the maintenance in it PT are studied. For both PT marks the increase in comparison durability is observed.

Now continuous growth of manufacture and application of polymeric composite materials is observed. The important place among them is borrowed with polymeric mixes which enable to receive materials with the improved properties in comparison with initial components (the raised shock durability, water resistance, smaller density, etc.) [1]. The majority of polymers do not possess mutual solubility, i.e. are incompatible. Their mix is characterized by the certain distribution of polymer particles of one nature in a matrix of another. Thus interaction of components is carried out in an interphase layer of small extent (up to 10nm) where occurs limited diffusion of polymeric circuits. Besides at reception of such mix there is an formation opportunity of chemical communications between a surface polymeric filler and connector. Polymers incompatible among themselves are polypropylene (PP) and polythene (PT). Both materials find wide application, have the merits and demerits. In a mix they show the raised electric and mechanical durability [2]. Addition PT to PP raises frost resistance of the last. Depending on conditions of polymerization receive PT marks, differing in density and a degree cryctallity [3]. Polythene of low density (PTLD) has density from 910 up to 935 kg/m³ and a degree cryctallity less than 60 %. Polythene of high density (PTHHD) is characterized by density from 945 up to 955 kg/m³ and a cryctallity degree 70-80 %. For PP these characteristics make 900-910 kg/m³ and 73-75 % accordingly. Ultrasonic researches polymer-polymeric of a composition of software-IIЭ earlier were not spent. Meanwhile, such researches allow to receive the information on physical characteristics, properties, structure and internal structure of polymeric materials [4]. Therefore the big attention [5-8] is paid to acoustic methods of polymers research. The purpose of the present work was experimental studying influence of PTLD and PTHHD content on acoustic characteristics of a PP-PT mix and the analysis of its internal structure on the basis of acoustic measurements results.

Experimental researches were spent on PP of mark 01030 to mixes with PTLD or PTHHD at change of their maintenance from 0 up to 50 %. For reception of a polymeric mix the granulated initial components all over again inmixed in the mechanical amalgamator, then granulations were exposed and in the further were processed by moulding under pressure on automatic injection machine. The standard samples received at it for physical and chemical tests represented plates thickness of 3,3 mm and width 13 mm. In connection with small samples thickness the velocity and attenuation measurements was carried out by a buffer method. The impulse duration was 5 μs, and the period of their following 200 μs. The relative error of velocity measurement did not exceed 0,5 %, factor of attenuation – 5 %. The mechanical part of experimental installation is in detail described in [8]. The velocity definition of longitudinal acoustic waves distribution in investigated materials was carried out on a difference of times of arrival of the first acoustic impulses in systems the buffer-sample-buffer and the buffer-buffer. The factor of attenuation α was defined under the attitude of impulse amplitudes U and U_0 after propagation the buffer-sample-buffer for the investigated sample and the standard sample of PP with known attenuation factor accordingly.

Results of measurement of phase velocity V and attenuation factor α of longitudinal waves in investigated samples depending on % of mass content PT in PP are resulted on fig. 1 and 2 accordingly (a dotted line the presumable curves course is shown in the field of where measurements were not spent). It is visible, for PTHD velocity and attenuation change practically monotonously between values of these characteristics for PP and the given mark PT. It can be caused by strong enough interaction of components in an interphase layer and formation enough a long layer of segmental compatibility, not dependent on concentration of mix components. For PTLD the attenuation minimum is observed at 20 % content PT (fig. 2) and nonmonotonic change of velocity (fig. 1) near to this area of concentration. Such dependences can specify that at reception of the given mix there is a formation of chemical communications between PP and PT owing to course of mechanical destruction processes of initial mixed components molecules, and this process essentially depends on a parity of mixed components. The number of defects as a result decreases and mix viscosity in the given range of concentration decreases. It is possible to assume, that dependence of attenuation factor versus % content of mix polymers components is directly connected with their mutual solubility. This dependence can be monotonous at enough good mutual solubility (fig.2, PTHD) to have a minimum (fig. 2, PTLP) at formation of chemical communications between mix components or a maximum at bad mutual solubility, as for a mix of software-shock-resistant polystyrene [9].

The curve property-structure for the dynamic longitudinal module $M = \rho V^2$, (1) received on the basis of the measured velocity values, is resulted on fig. 3. At 10-20 % PTLD content this curve goes below additive dependence (a straight line to which can connect initial and final points of the schedule), that also testifies [3] to decrease in viscosity and, hence, increase of ability to processing in the given concentration range. For PTHD the given dependence is close to additive, that can be connected with presence of an interphase layer between mix components.

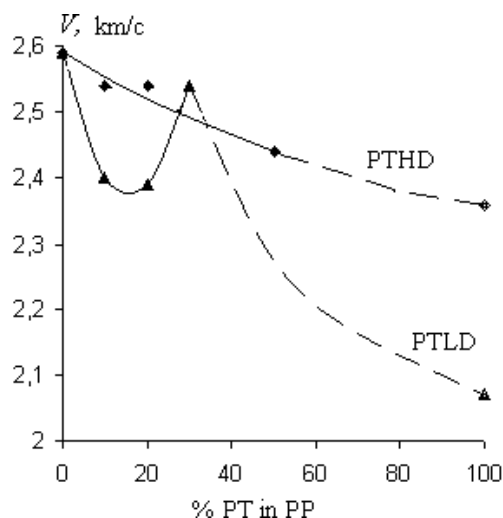


Fig. 1. Dependence of longitudinal velocity V versus % PT content

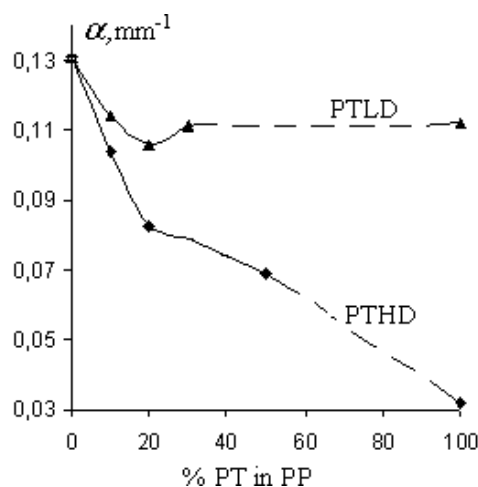


Fig. 2. Dependence of attenuation factor α versus % PT content

Mechanical durability R of investigated samples can be estimated by results of acoustic

measurements according to the formula [4]:
$$\frac{R_2}{R_1} = \frac{\rho_2 V_2^2 \Delta_1}{\rho_1 V_1^2 \Delta_2}, \quad (2)$$

where R_1 and R_2 - durabilities of PP and a mix of PP-Pt accordingly, $\Delta = \alpha \lambda$ - decrement of

attenuation. Passing in (2) from Δ to α , we shall receive:
$$\frac{R_2}{R_1} = \frac{\rho_2 V_2 \alpha_1}{\rho_1 V_1 \alpha_2}. \quad (3)$$

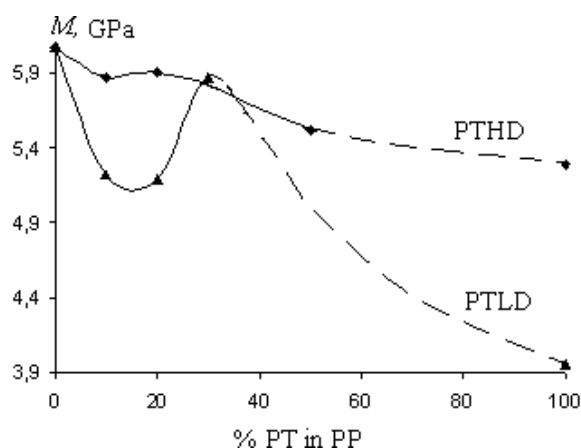


Fig. 3. The longitudinal elastic module M versus % PT content

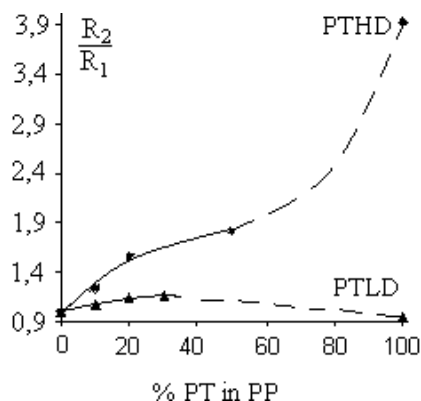


Fig. 4. The relative mechanical durability R_2 / R_1 versus % PT content

On fig. 4 dependences of the attitude of durabilities R_2 / R_1 on % PT content in a mix with PP are resulted. Apparently from schedules, both marks $\Pi\Theta$ give increase in durability in comparison from software. This result coincides with received in [2]. The Fig. 4 shows, that at 20-30 % PT content the mix durability became on 15 % more than durability of initial components. It also testifies to stronger intermolecular interaction between PP and PTLT at the given concentration. Durability of a mix with $\Pi\Theta\text{B}\Pi$ monotonously changes at increase in concentration $\Pi\Theta$ between values of this size for software and the given mark $\Pi\Theta$, and for $\Pi\Theta\text{B}\Pi$ $R_2 / R_1 = 3,9$.

The received results testify to various behaviour of a mix of PP-PT for PTHD and PTLT. In case of PTHD dependence of testimonials from of a mix components parity is close to additive. For PTLT these characteristics essentially deviate additive dependence, especially at 20 % PT content. At same PTLT concentration the maximum of relative lengthening has been received at break of a material. Hence, interaction on interphase border depends not only on the chemical nature of initial components, but also from their parity in a mix.

The results received in yielded work testify to an opportunity of application of a ultrasonic quality monitoring for research of the interphase phenomena on border polymer-polymer and can be used for an estimation of mutual polymers solubility. Advantage of the given method in comparison with known is that its application does not change property and structure of a material.

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